UNITED STATES TARIFF COMMISSION
WASHINGTON

INFORMATION

CONCERNING THE

PYRITES AND SULPHUR INDUSTRY

PRINTED FOR USE OF
COMMITTEE ON WAYS AND MEANS
HOUSE OF REPRESENTATIVES

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Office: 1322 New York Avenue, Washington, D. C.

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LETTER OF TRANSMITTAL.

UNITED STATES TARIFF COMMISSION,
Washington, June 14, 1919.

The Committee on Ways and Means of the House of Representatives:

I have the honor to transmit herewith, in accordance with your request, information compiled by the United States Tariff Commission on the pyrites and sulphur industry.

Very respectfully,

THOMAS WALKER PAGE,
Acting Chairman.

PART I. INTRODUCTION.

SUMMARY OF THE PYRITES AND SULPHUR SITUATION.

Pyrites is a natural mineral composed of iron and sulphur chemically combined. Many deposits of pyrites contain a small per cent of copper which may be recovered as a valuable by-product. Pyrites is used as a raw material for the manufacture of sulphuric acid. The uses of sulphuric acid are so large, so varied, and so essential that it is undoubtedly the most important material of the chemical industries. It is used for making superphosphate of lime and sulphate of ammonia which are important ingredients for fertilizers, for refining petroleum, the manufacture of tin plate, galvanized iron, and enameled iron, the manufacture of explosives, celluloid, dyes, and scores of other purposes.

Sulphur is one of the chemical elements which occurs in nature in a free state and also chemically combined in a great variety of minerals including pyrites, zinc, and copper ores and gypsum. Sulphur can be used for the manufacture of sulphuric acid and in addition has a great variety of other uses, including the manufacture of paper, as a preventive and remedy for fungous diseases of plants (either alone or combined with lime), for the vulcanization of rubber, the manufacture of some varieties of matches and old-fashion black gunpowder, the manufacture and application of the so-called "sulphur" dyes, and many other chemicals. The introduction of poison gas warfare brought a new use for sulphur in the manufacture of mustard gas.

Both pyrites and sulphur may be used in the manufacture of sulphuric acid, and therefore the producers of sulphur and pyrites are at least potential rivals in supplying the raw material for the largest of all chemical industries. Pyrites on an average contain from about 40 per cent of sulphur for the domestic product to about 48 per cent for the Spanish product, while native sulphur produced in the United States is usually more than 99 per cent pure. This gives sulphur a decided advantage over pyrites in regard to freight rates, since over twice as much pyrites as sulphur must be transported to obtain equivalent amounts of sulphur. Sulphur has other advantages over pyrites as a raw material for sulphuric acid making. It burns more readily and requires less labor in handling, gives a purer product and gives a larger output from any given sulphuric-acid plant. This is offset in part by the recovery of copper as by-product from the pyrites from some mines. The present and prospective condition of competition between these two commodities to supply the sulphur required in the manufacture of sulphuric acid can best be shown by a short historical discussion of these two industries.

Sulphur has been produced commercially in Sicily for several hundred years past, and it was the first raw material to be used in the

manufacture of sulphuric acid. For many years past and up until about 1903, Sicily supplied over 95 per cent of the world's demand for native sulphur. Sulphur was used to the exclusion of pyrites in the manufacture of sulphuric acid until the year 1838. At this time a monopoly of the Sicilian export trade in sulphur was placed in the hands of a French company (MM. Taix & Cie. of Marseille), which nearly tripled the price of sulphur. This forced the English manufacturers of sulphuric acid to seek a cheaper raw material and iron pyrites, which is found in enormous deposits in Spain and Portugal, proved to be satisfactory as the raw material for sulphuric acid. During the next 20 years sulphur was gradually but steadily replaced by pyrites in the manufacture of sulphuric acid. The Sicilian producers have never since been able to regain the sulphuric-acid trade, because they could not sell sulphur cheap enough to replace pyrites.

The chemical industries in the United States developed several decades after the English chemical industries and, in the beginning at least, followed English practice. Pyrites became the raw material used for practically all of the sulphuric acid made in this country. In recent years, however, considerable sulphuric acid has been made from the waste fumes of the smelters, especially those roasting copper and zinc sulphide ores. Very little sulphur was used in the manufacture of sulphuric acid. The pyrites required was chiefly imported ore from Spain and Portugal. There was, however, some development of domestic deposits, which supplied about 25 per cent of the consumption in this country prior to the war.

In 1865 a large underground deposit of sulphur was found in western Louisiana. There followed nearly 30 years of effort on the part of different companies to successfully work this deposit by ordinary mining methods. Owing to the overburden of quicksand impregnated with poisonous hydrogen sulphide gas, all of these attempts resulted in failure and loss of life and of capital. In 1903 an ingenious and radically new method for obtaining sulphur from this deposit invented by Herman Frasch, an American engineer, proved to be an industrial success. The essential feature of the Frasch process is to sink a well about 1 foot in diameter down to the sulphur deposit and then pump hot water under high pressure into the sulphur. The hot water melts the sulphur and forces it to the surface through a smaller inner tube. From this time on the American market for sulphur in the manufacture of paper and chemicals was lost to the Sicilian producers. The Frasch process, which has been developed and exploited by the Union Sulphur Co., has proved to be a great industrial and financial success. Shortly before the outbreak of the European war the Union Sulphur Co. had made preparations to enter on a large scale the European market for sulphur, but the outbreak of the war caused these plans to be postponed. In 1915 the United States became the leading producer of sulphur and is now apparently in a position of commanding importance in the sulphur markets of the world.

The domestic producers of sulphur, prior to the war, did not attempt to compete with pyrites in the manufacture of sulphuric acid. They were able to realize larger profits by maintaining the price of sulphur at $22 per ton f. o. b. New York and supplying the paper and chemical trade rather than by reducing the price of sulphur to a point where they could obtain the sulphuric-acid business. The war has caused a

decided change in the pyrites and sulphur situation in the United States. The demand for sulphuric acid during the war for the manufacture of explosives increased so that the production in 1917 was about twice the production in 1913. The difficulty and lack of ocean shipping made it impossible to meet this large increased demand with Spanish pyrites. Moreover domestic pyrites, although the production increased about 35 per cent during the war, was unable to meet the total demand and sulphur, therefore, was used in large quantities in the manufacture of sulphuric acid. The annual domestic production of sulphur has increased more than 1,000,000 tons since 1914 when the production was 327,634 long tons. This represents an increase of over 300 per cent as compared to about a 35 per cent increase in the domestic production of pyrites.

The competitive conditions in the sulphur industry have changed greatly during the war. The original Frasch patents owned by the Union Sulphur Co., which formerly gave this company a practical monopoly of the sulphur market in this country, have expired and later patents on modifications of this process have recently been declared void by the Circuit Court of Appeals of the Third Circuit. The Freeport Sulphur Co. has developed a large output during the war. A third large company, The Texas Gulf Sulphur Co., began production on a large scale in March, 1919. It is expected that there will be sharp competition between these companies. Should this occur and these sulphur producers undertake to supply the requirements of the sulphuric acid manufacturers in the United States, it is assumed that the price of sulphur will decrease.

The stocks of sulphur above ground and ready for shipment at the mines is estimated to be about 1,500,000 tons, nearly five times the annual prewar consumption in this country. The Federal Trade Commission has reported (see p. 25) that the cost of producing sulphur in Louisiana and Texas during 1917 was about $6 per ton. These figures indicate that the sulphur producers can reduce the price of sulphur to a point where the imported Spanish pyrites will not compete in the production of sulphuric acid.

Under such conditions, American sulphur producers, regardless of any tariff duties, enjoy comparative advantages making them independent of foreign competition. For like reasons, American pyrites producers can expect little, if any, benefit either from a duty on sulphur or one on pyrites. The serious competition which domestic pyrites producers face comes from American sulphur, not from imported pyrites.

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PART II. THE PYRITES INDUSTRY.

PYRITES OR SULPHURET OF IRON.

DESCRIPTION.

Par. 617. * * * and sulphur ore as pyrites, or sulphuret of iron in its natural state, containing in excess of 25 per centum of sulphur.

The name "pyrites" in more recent years has been used to signify a variety of sulphide minerals possessing a metallic luster and a hardness of about 6. However, the term as generally used and as used in the tariff act of 1913 "Pyrites or sulphuret of iron" refers to the disulphide of iron, FeS_2. Chemically, when pure, it is composed of 53.3 per cent of sulphur and 46.7 per cent of iron, but that commonly used for the manufacture of sulphuric acid contains from 43 to 48 per cent of sulphur. An ore containing less than 35 per cent sulphur is seldom used for making sulphuric acid, as it will not support its own combustion. The ore is usually mixed with gangue or more frequently with other sulphuretted ores, such as pyrrhotite and copper pyrites.

Pyrites occurs as a dense, hard mineral of crystalline structure and pale yellow color. This color, similar to gold, has caused the mineral to be mistaken for gold, with the resulting name of "fools gold" being applied to it. Pyrites also occurs associated with deposits of coal.

The ore burns in the presence of air with a small blue flame and is capable of supporting its own combustion. The products of combustion are sulphur dioxide and ferric oxide. The formation of the former, when pyrites is burned, is the property that gives pyrites its wide use in the manufacture of sulphuric acid.

Pyrites as commercially used is generally referred to as lump or fines. The lump ore consists of pieces more than an inch in diameter, with a certain allowable proportion of smaller particles, and it is used as it comes from the mines with little more than a sorting according to size. The fines are smaller particles and generally have been obtained by crushing the ore so small that the pyrite can be separated from the worthless gangue by some mechanical means, or the ore has disintegrated through having been leached. Owing to the different methods necessary to burn these two ores for the utilization of the sulphur, they can not be used interchangeably in the same burner; that is, each grade requires a special type of burner. The lump ore commands the higher price, but, of course, it is more difficult to obtain a lump ore with as high a sulphur content as that of fines. As a result only a few mines can furnish lump ore and maintain a high enough sulphur content, whereas suitable fines may be obtained even from deposits in which the pyrite is sparsely disseminated.

Commercial transactions in pyrite ore are based on the percentage content of sulphur. The price quotations on pyrites refer to a unit, which is 1 per cent of sulphur per ton of ore, or 20 pounds. For example, if the price is 17 cents per unit and the ore on analysis showed 50 per cent sulphur, the price per ton of ore would be $8.50.

IMPORTANT USES.

The chief use of pyrites is for the manufacture of sulphuric acid, which is an important material for the manufacture of acid phosphate for fertilizers. About 1,250,000 tons are consumed each year in the United States for the manufacture of sulphuric acid. The iron oxide that remains as a residue after the burning of the ore is sometimes ground and sold for use as a pigment for paints, or it may be used as iron ore. However, in many plants it is a waste product. The Spanish pyrites usually contain sufficient copper to pay for recovering it from the residue after the sulphur has been burned out.

DOMESTIC PRODUCTION.

GEOGRAPHICAL DISTRIBUTION.

Prior to 1915, Virginia produced about 50 per cent of the domestic output of pyrites. California was the next largest producing State. From 1914 to 1918 the production of Virginia remained about constant while the production of California has increased until it is nearly equal to that of Virginia. These two States produce about 65 per cent of the total output.

There are four main areas containing promising pyrite deposits in the United States: (1) The Appalachian Mountain region; (2) the interior States, where it is a by-product of coal mining; (3) the Rocky Mountain States; and (4) in the Coast Ranges. More than three-fourths of the domestic consumption of pyrites is in the region east of the Mississippi River. As a consequence the western deposits can not compete in the eastern market against Spanish pyrites and can not be profitably utilized except for local demands.

Production in United States, by States.

[Figures from reports of the United States Geological Survey.]

States.	1910		1911		1912	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Long tons.		*Long tons.*		*Long tons.*	
California	27,158	$129,504	48,415	$182,787	61,812	$201,453
Illinois	8,541	28,159	17,441	47,020	27,008	62,980
Indiana	(1)	(1)	(1)	(1)	1,462	5,684
Ohio	3,766	12,831	6,471	18,017	14,487	43,853
Virginia	140,106	525,437	150,800	558,494	162,478	621,219
Wisconsin	12,555	49,467	12,893	50,025	17,898	70,518
Other States	49,486	232,580	65,438	308,528	65,783	328,552
Total	241,612	977,978	301,458	1,164,871	350,928	1,334,259

States.	1913		1914		1915	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Long tons.		*Long tons.*		*Long tons.*	
California	70,536	$218,525	71,272	$235,129	132,270	$496,111
Georgia	11,110	55,094	(1)	(1)	(1)	(1)
Illinois	11,246	31,966	22,538	59,079	14,849	22,476
Indiana	1,242	3,115	1,710	5,281	972	3,080
Ohio	13,622	34,998	7,279	19,718	10,857	27,404
Virginia	148,259	587,041	141,276	556,091	145,050	729,644
Wisconsin	25,328	94,727	14,188	78,460	13,985	43,354
Other States	59,995	260,618	78,399	329,588	76,141	352,864
Total	341,338	1,286,084	336,662	1,283,346	394,124	1,674,933

[1] Included in other States.

Production in United States, by States—Continued.

States.	1916		1917		1918 [1]	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Long tons.		*Long tons.*		*Long tons.*	
California	145,762	$565,699	115,817	$333,501	111,861	.....
Georgia	(2)	(2)	23,242	155,560	31,315	.....
Illinois	20,482	51,432	24,596	89,998	24,369	.....
Ohio	13,551	36,114	13,218	29,557	9,845	.....
Virginia	148,502	925,243	170,382	1,378,043	134,172	.....
Other States	95,259	387,214	115,407	498,776	143,758	.....
Total	423,556	1,965,702	462,662	2,485,435	455,320	.....

[1] Published by permission from advance sheets of Mineral Resources. Preliminary figures subject to revision.
[2] Included in other States.

PRODUCTION AND CONSUMPTION.

The domestic production of pyrites prior to the war was about 340,000 long tons, valued at about $1,250,000. The production has been greatly stimulated during the war by the large increased demand for sulphuric acid. In 1917 the production increased to 462,662 long tons, valued at $2,485,435. This represents a 35 per cent increase over the prewar production, but only a 10 per cent increase over the production in 1916. The increase was due primarily to the increased output of existing mines rather than from developments of new deposits. The domestic production in 1918 was expected to be greater than in 1917, but it decreased to 455,320 long tons.

The domestic production prior to the war supplied about 25 per cent of the total consumption of pyrites in the United States. In 1917 the domestic production supplied about 32 per cent of the consumption in the United States and in 1918 about 48 per cent. The increase is due to a decrease in imports rather than an increase in domestic output. The following table shows the production, importation, and consumption of pyrites since 1910:

Production, imports, and consumption of pyrites.[1]

Year.	Production.	Imports.	Consumption.	Year.	Production.	Imports.	Consumption.
	Long tons.	*Long tons.*	*Long tons.*		*Long tons.*	*Long tons.*	*Long tons.*
1910	241,612	803,551	1,045,163	1915	394,124	964,634	1,358,758
1911	301,458	1,006,310	1,307,768	1916	423,556	1,244,662	1,668,218
1912	350,928	970,785	1,321,713	1917	462,662	967,340	1,430,002
1913	341,338	850,592	1,191,930	1918	455,320	496,792	952,112
1914	336,662	1,026,617	1,363,279				

[1] Production from reports of the Geological Survey, imports from Commerce Department.

Production of pyrites in United States.

[Figures from United States Geological Survey.]

Year.	Long tons.	Value.	Value per long ton.	Year.	Long tons.	Value.	Value per long ton.
1900	204,615	$749,991	$3.68	1913	341,338	$1,286,084	$3.77
1904	207,081	814,808	3.94	1914	336,662	1,283,346	3.81
1909	247,070	1,028,157	4.20	1915	394,124	1,674,933	4.25
1910	241,612	977,978	4.05	1916	423,556	1,965,702	4.64
1911	301,458	1,164,871	3.86	1917	462,662	2,485,435	5.58
1912	350,928	1,334,259	3.80	1918[1]	455,320	.....	.....

[1] Published by permission from advance sheets of Mineral Resources. Preliminary figures subject to revision.

HISTORY OF THE INDUSTRY.

Pyrites has been known from early times, when deposits were worked for the copper which the ore contained. The ore assumed no great importance until it was discovered that it could be used instead of sulphur in the manufacture of sulphuric acid.

The first application of pyrites in the making of sulphuric acid is described in an English patent in 1818. However, there was not much development along this line until in 1838, when the Sicilian Government granted a monopoly for the exportation of Sicilian sulphur to the Marseilles firm of Taix & Co. This firm at once tripled the price of sulphur with the result that the manufacturers of sulphuric acid sought a cheaper raw material. This lead to the development of the use of pyrites as the source of sulphur necessary for the manufacture of sulphuric acid. In 1839 pyrites was first used on a large scale in England for the manufacture of sulphuric acid.

The Sicilian monopoly on sulphur did not last long and some of the producers of sulphuric acid returned to sulphur as the raw material, but during the next 20 years sulphur was, gradually but steadily, replaced by pyrites for the production of sulphuric acid.

The use of iron pyrites as the raw material for sulphuric acid has been followed by the utilization of the gases from the smelting of copper and zinc sulphide ores. These gases were formerly allowed to escape and were a great nuisance to the surrounding country, until legal pressure forced the companies to find a way of utilizing the gases. To-day the copper and zinc smelters constitute one of the important sources of sulphuric acid in this country.

Pyrites at the beginning of the war was recognized as the cheapest raw material for the manufacture of sulphuric acid. However, sulphur, during the war, was used in the manufacture of sulphuric acid on a scale greater than ever before, owing to the increased demand for sulphuric acid and the decrease and restriction of the import of Spanish pyrites. It is very likely that sulphur in the future will offer serious competition to pyrites in the manufacture of sulphuric acid.

FOREIGN PRODUCTION.

Spain and Portugal possess the largest deposits of pyrites that are known. The production of these two countries supplies about three-fourths of the world's demands. Of these two countries Spain is by far the largest producer. Spanish ore, especially that coming from Rio Tinto, has long been considered to be the best for the manufacture of sulphuric acid. It is a copper-bearing ore, and contains about 3 per cent of this metal, which is usually recovered from the residue after the sulphur has been burned out. The Spanish ore as a rule never contains less than 46 per cent of sulphur and as high as 52 per cent. The principal Spanish mines are controlled by French or English capital. Pyrites is used in Spain as copper ore also and the residue after the copper is extracted is suitable for sulphuric acid making. The potential output of Spanish pyrites is represented by both copper mineral and iron pyrites. The other countries producing over 200,000 long tons are the United States, France, Germany, Norway, Italy, and Portugal.

Production of pyrites in principal countries.

[From Mineral Industry, 1917.]

[Quantity, long tons, 2,240 pounds.]

Countries.	1910	1911	1912	1913	1914	1915
Belgium	210	120	146	264	(1)	(1)
Bosnia	562	3,069	6,118	3,191	4,389	(1)
Canada	48,099	73,794	72,776	141,610	200,902	255,397
England	10,229	10,114	10,522	11,428	11,661	10,542
France	246,478	273,512	277,746	306,254	(1)	(1)
Germany	212,302	214,025	238,298	224,798	(1)	(1)
Greece	32,768	35,392	29,296	126,845	127,111	11,922
Hungary	91,004	95,226	102,170	104,945	100,754	(1)
Italy[2]	163,072	162,663	273,202	312,232	330,233	363,488
Japan	77,180	72,712	73,746	112,780	114,013	66,470
Newfoundland	Nil.	2,461	Nil.	.....	.....	.....
Norway	316,916	344,474	461,915	434,252	408,335	505,299
Portugal	307,965	278,308	[3] 591,946	[3] 384,908	[2] 72,245	(1)
Russia	55,096	111,269	122,032	[4] 127,947	(1)	(1)
Spain[5] Copper mineral	3,180,362	3,232,294	3,311,138	2,232,846	1,478,857	1,456
Spain[5] Iron pyrites	289,536	339,430	414,417	912,268	969,324	789,705
Sweden	25,043	29,621	31,332	33,777	32,787	75,119
United States	223,691	300,158	351,074	341,547	336,681	393,161

Countries.	1916	1917	Countries.	1916	1917
Belgium	(1)	(1)	Japan	89,663	(1)
Bosnia	(1)	(1)	Newfoundland	.....	.....
Canada	276,122	360,045	Norway	295,263	(1)
England	10,488	8,515	Portugal	(1)	(1)
France	(1)	(1)	Russia	(1)	(1)
Germany	(1)	(1)	Spain[5] Copper mineral	1,745,893	1,871,299
Greece	19,623	(1)	Spain[5] Iron pyrites	938,610	370,963
Hungary	(1)	(1)	Sweden	96,303	(1)
Italy	403,812	(1)	United States	423,816	462,946

[1] Reports not available.
[2] Cupriferous in part.
[3] Includes 120,148 tons copper iron pyrites in 1912 and 13,550 tons in 1913.
[4] Estimated.
[5] Taken directly from Estadistica Minera de Espana instead of from Mineral Industry.

IMPORTS.

The imports of pyrites have averaged about 980,000 long tons from 1910 to 1917, inclusive, with a maximum import of 1,244,662 long tons in 1916. The import of pyrites from Spain and Portugal in 1918 was restricted by the Government to 600,000 tons, owing to the scarcity of available shipping space. The actual importation during 1918 was only 496,792 long tons. (Above figures are for the calendar years.) The imports of pyrites from Canada during the fiscal year 1918 was about six times the prewar import from that country.

Imports have furnished about 70 per cent of the domestic consumption of pyrites.

Imports of pyrites by countries.

Imported from—	1909		1910		1911	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
Portugal	71,839	$244,970	86,264	$291,083	117,996	$391,375
Spain	545,448	2,064,276	601,536	2,197,613	742,758	2,609,457
Canada	43,882	152,467	39,500	131,121	29,977	91,392
All other	100	500	2,202	6,888	3,550	15,865
Total	661,269	2,462,213	729,502	2,626,705	894,281	3,108,089

Imported from—	1912		1913		1914	
Portugal	117,914	$390,969	118,732	$392,296	102,150	$333,978
Spain	840,229	3,388,029	814,534	3,632,392	638,711	2,966,682
Canada	37,103	140,202	31,293	86,948	79,141	312,575
All other	50	250	.....	.....	12,132	82,100
Total	995,296	3,919,450	964,559	4,111,636	832,134	3,695,335

Imported from—	1915		1916		1917	
Portugal	57,109	$189,710	46,351	$151,445	16,475	53,425
Spain	687,812	3,531,048	1,207,323	6,489,892	747,866	5,170,447
Canada	99,738	386,491	120,896	473,625	171,268	632,041
All other	.....	.....	471	6,652	.....	.....
Total	844,659	4,107,249	1,375,041	7,121,614	935,609	5,855,913

Imported from—	1918.	
	Long tons.	Value.
Portugal	2,700	$7,700
Spain	596,583	3,709,368
Canada	205,163	765,429
All other	5,629	39,838
Total	810,075	4,522,335

Imports of pyrites for consumption.

Fiscal years.	Rates of duty.	Quantities.	Values.	Duties collected.	Value per long ton.	Actual and computed ad valorem rate.
		Long tons.				
1909	Free	661,712	$2,462,154	.....	$3.73	.....
1910	...do	723,277	2,617,725	.....	3.62	.....
1911	...do	893,487	3,108,090	.....	3.48	.....
1912	...do	1,004,048	3,900,145	.....	3.88	.....
1913	...do	966,575	4,112,057	.....	4.25	.....
1914	...do	846,905	3,753,879	.....	4.43	.....
1915	...do	875,949	4,139,649	.....	4.73	.....
1916	...do	1,370,059	7,121,614	.....	5.19	.....
1917	...do	935,749	5,855,913	.....	6.25	.....
1918	...do	808,084	4,496,563	.....	5.57	.....

TARIFF HISTORY.

Pyrites or sulphuret of iron has been wholly free of duty since the passage of the act of 1894. Prior to this time such ore containing copper in excess of 2 per cent was assessed a duty on the copper content. The following table shows the tariff description of pyrites under the various acts, beginning with the act of 1894:

Rates of duty.

Act of—	Paragraph.	Tariff classification or description.	Rates of duty, specific and ad valorem.
1894.....	642	* * * sulphur ore, as pyrites, or sulphuret of iron in its natural state, containing in excess of twenty-five per centum of sulphur * * *.	Free list.
1897.....	674	* * * sulphur ore as pyrites, or sulphuret of iron in its natural state, containing in excess of twenty-five per centum of sulphur * * *.	Do.
1909.....	686	* * * sulphur ore as pyrites, or sulphuret of iron in its natural state, containing in excess of twenty-five per centum of sulphur * * *.	Do.
1913.....	617	* * * and sulphur ore as pyrites, or sulphuret of iron in its natural state, containing in excess of twenty-five per centum of sulphur * * *.	Do.

PRICES.

The price of Spanish pyrites increased about 50 per cent during the war, while the price of domestic pyrites has increased from three to four times over the prewar prices. The following table shows the wholesale prices of pyrites in the New York market:

Wholesale prices, spot, New York market, in cents per unit.[1]

[Data from Oil, Paint, and Drug Reporter.]

Kinds of grades.	Spanish lump, unbroken.	Spanish crude, 48–52 per cent, export shipment.	Spanish smalls, washed, fines.	Furnace lump ore, washed, 48–52 per cent.	Spanish lump, washed.	Furnace nonarsenic less $\frac{1}{16}$ of 1 per cent arsenic.	Domestic concentrates, f. o. b. mill.
1912.							
January	12½–13½	10½–11	10½–11	12½–13	12–13	12¾–13¾	12½–13
April	12½–13½	10½–11	10½–11	12½–13	12–13	12¾–13¾	12½–13
July	—@13½	10½–11	10½–11	—@13	—@13	13 –13¾	—@13
October	—@13½	10½–11	10½–11	—@13	—@13	13 –13¾	—@13
1913.							
January	—@13½	10½–11	10½–11	—@13	—@13	13 –13¾	—@13
April	—@13½	10½–11	10½–11	—@13	—@13	13 –13¾	—@13
July	—@13½	10½–11	10½–11	—@13	—@13	13 –13¾	9 – 9½
October	—@13½	10½–11	10½–11	—@13	—@13	13 –13¾	9 – 9½
1914.							
January	—@13½	10½–11	10½–11	—@13	—@13	13 –13¾	9 – 9½
April	—@13½	10½–11	10½–11	—@13	—@13	13 –13¾	9 – 9½
July	—@13½	10½–11	10½–11	—@13	—@13	13 –13¾	9 – 9½
October	—@13½	10½–11	10½–11	—@13	—@13	13 –13¾	7 – 9½
1915.							
January	—@13½	10½–11	10½–11	—@13	—@13	13 –13¾	7 – 9½
April	—@13½	10½–11	10½–11	—@13	—@13	13 –13¾	7 – 9½
July	—@13½	10½–11	10½–11	—@13	—@13	13 –13¾	7 – 9½
October	—@13½	10½–11	10½–11	—@13	—@13	13 –13¾	7 – 9½
1916.							
January	—@16	15 –15½	15 –15½	—@15½	—@15½	1 @ –	..
April	—@16	15 –15½	15 –15½	—@15½	—@15½	16@—	11 –12
July	—@16	15 –15½	15 –15½	—@15½	—@15½	16@—	11 –12
October	—@16	16 –16½	16 –16½	—@15½	—@15½	16@—	11 –12

[1] Unit is 1 per cent of sulphur per ton of ore.

Wholesale prices, spot, New York market, in cents per unit—Continued.

Kinds of grades.	Spanish lump, unbroken.	Spanish crude, 45–52 per cent, export shipment.	Spanish smalls, washed, fines.	Furnace lump ore, washed, 48–52 per cent.	Spanish lump, washed.	Furnace nonarsenic less $\frac{1}{16}$ of 1 per cent arsenic.	Domestic concentrates, f. o. b. mill.
1917.							
January	—@16	16–16½	16–16½	—@15½	—@15½	16@—	11–12
April	—@16	16–16½	16–16½	—@15½	—@15½	16@—	11–12
July	—@16	16–16½	16–16½	—@15½	—@15½	16@—	11–12
October	—@16	16@—	16@—	16–16½	16–16½	16–16½	11–12
1918.							
January	16–16½	16@—	16–16½	16–16½	16–16½	16–16½	25–30
April	17–17½	17@—	17@—	17–17½	17–17½	17–17½	(2)
July	17–17½	17@—	17@—	17–17½	17–17½	17–17½	28–30
October	17–17½	17@—	17@—	17–17½	17–17½	17–17½	30–33
1919.							
January	17–17½	17@—	17@—	17–17½	17–17½	17–17½	27–28
April	17–17½	17@—	17@—	17–17½	17–17½	17–17½	(2)

[2] Nominal.

PART III. THE SULPHUR INDUSTRY.

SULPHUR OR BRIMSTONE.

DESCRIPTION.

Sulphur or brimstone, a free chemical element, has been known from the earliest time. It occurs in the free state in the vicinity of volcanoes, active and extinct. It is a characteristic product of volcanic action. Sulphur also occurs in nature in chemical combination with other elements. The most important of these compounds are the sulphides of iron, copper, lead, and zinc; and the sulphates of calcium, magnesium, barium, and sodium.

Sulphur comes into commerce in several forms, such as crude, refined or sublimed, flowers of, and precipitated or milk of sulphur. The refined or sublimed and flowers of sulphur are grades of high purity and are made from the crude sulphur or brimstone by distillation and condensation. The crude brimstone produced in this country, owing to the ingenious method of mining, is guaranteed to contain 95.5 per cent pure sulphur and often grades as high as 99.9 per cent. This distinction in the forms of sulphur is recognized in the tariff act of 1909 and earlier acts, which levy a duty on "Sulphur, refined or sublimed, or flowers of," although no standard of purity or quality is stated. Under the act of 1913 all grades of sulphur are free of duty.

The commercial sulphur of Sicily contains from 2 to 11 per cent of impurities and is known as "greggio," which is graded as "best unmixed seconds," "best unmixed thirds," and "current thirds." These three qualities represent the entire trade of Sicily in brimstone. The refined Sicilian sulphur, known as "raffinite," contains about one-half of 1 per cent of impurities.

HISTORY OF THE INDUSTRY.

Sulphur has been produced commercially in Sicily for several hundred years past. For many years past and up to 1903 about 95 per cent of the world's supply was mined and prepared for sale in that country.

In 1838 a monopoly of the Sicilian export trade in sulphur was placed in the hands of a French company (MM. Taix & Cie., of Marseille), which nearly tripled the price of sulphur. This increase in price forced the manufacturers of sulphuric acid to learn how to use iron pyrites as their source of sulphur. As a result the Sicilian producers lost all of this trade, which they have never been able to regain. Then followed the withdrawal of the French monopoly with the subsequent reestablishment of the old price of about $25 per ton for sulphur.

The next important event in the history of the sulphur industry was the development, in about 1890, of the Chance-Claus process for the recovery of sulphur from the alkali waste of the Le Blanc soda process. Advantage was taken of the possibilities of this process to cause internal competition among the Sicilian producers, with the result that the selling price of brimstone was reduced to about $11 per ton, out of which had to be paid the export tax of $1.95 per ton. This state of affairs continued for some time, until 1896, when the Sicilian laborers were on the verge of starvation and revolution. In this year efforts originating in England resulted in the combination of the British and Sicilian interests with the formation of the Anglo-Sicilian Sulphur Co. This combination received the hearty support of the Italian Government, which reduced the export tax on sulphur to 1 lire (19.3 cents) per ton. There followed an increase in the wages of the laborers, abolishment of child labor, and withdrawal of heavy income taxes. The formation of this company resulted in fair and satisfactory prices to both the consumer and producer and a period of 10 years of peace and prosperity in Sicily.

In 1865 a large underground deposit of sulphur was found in western Louisiana. There followed nearly 30 years of effort on the part of different companies to successfully work this deposit by the ordinary mining methods. They all resulted in failure, loss of life and of a large amount of capital, until in 1903, when an ingenious method invented by Herman Frasch proved an industrial success. From this time on the American market in sulphur was gradually lost to the Anglo-Sicilian Sulphur Co. This company, therefore, exercised its option of terminating its agreement with the Sicilian producers in July, 1906. The Italian Government then placed the sale and regulation of the production of Sicilian sulphur in the hands of the "Consorzio Obbligatorio per l'Industria Solfifera Siciliana." At the same time sulphur was relieved of all export tax. The American output of sulphur has had a decided effect on the industry in Sicily. The sale of Sicilian sulphur, which up to 1903 was 95 per cent of the world's supply, has been reduced to about 50 per cent at the end of 1913. The maximum production of 559,767 long tons of sulphur in Sicily was reached in 1905, and has since fallen to as low as 343,973 long tons in 1913. In 1914 there was a slight gain to 397,061 long tons. The United States imports of Sicilian sulphur have decreased rapidly since 1903 until in 1913 they were negligible.

In 1915 the United States surpassed the other great sulphur-producing country, Sicily, and now occupies the dominating position in the sulphur industry of the world. Sulphur was used in large quantities in the production of sulphuric acid during the war owing to the large increased demand which could not be supplied by either imported or domestic pyrites. This caused an increase in the domestic production of more than 1,000,000 tons. It is expected that sulphur will again displace pyrites to a large extent in the manufacture of sulphuric acid in the United States.

LARGEST PRODUCERS.

The leading producing countries are the United States, Italy, Japan, and Chile in the order given. The size of the industry in each country is discussed individually as follows:

United States.—Prior to the successful development, in 1903, of the Louisiana sulphur deposit the sulphur production of the United States was less than one-half of 1 per cent of the consumption. In the following year, 1904, enough sulphur was produced to supply the entire domestic consumption. The output increased rapidly until in 1915 the United States obtained a decided lead over Sicily in the production of sulphur.

The two States of Louisiana and Texas in 1917 produced 99 per cent of the entire output of sulphur in this country. The remainder is produced in Nevada and Wyoming for local consumption. The production of sulphur in 1917 was about 1,350,000 long tons.

Production in United States.

[Figures from Mineral Resources of the United States.[1]]

Years.	Quantity.	Value.	Years.	Quantity.	Value.
	Long tons.			*Long tons.*	
1900	3,147	$88,100	1909	239,312	$4,432,066
1901	(2)	(2)	1910	255,534	4,605,112
1902	(2)	(2)	1911	265,664	4,787,049
1903	(2)	(2)	1912	303,472	5,256,422
1904	127,292	2,663,760	1913	311,590	5,479,849
1905	181,677	3,706,560	1914	327,634	5,954,236
1906	294,153	5,096,678	1915 [3]	410,000	.....
1907	293,106	5,142,850	1916 [4]	900,000	.....
1908	369,444	6,668,215	1917 [5]	1,350,000	.....

[1] Listed as marketed production.
[2] Not reported.
[3] Estimated; see Mineral Industry, vol. 25, p. 667.
[4] From statement of Freeport Sulphur Co., published in Mineral Resources for 1916, Pt. II, p. 403.
[5] Mineral Resources for 1917 reported that the 1917 production was about 50 per cent greater than in 1916.

Italy.—This country at the present time ranks second to the United States in the quantity of sulphur produced. The production for the year 1915 was 329,581 long tons, an amount less than the preceding year. In fact, the production of sulphur in Italy has been on the decline for several years, owing to competition from the United States. Since 1916 the export demand for England, France, Australia, Russia, and Sweden has been very active, but even in the face of this demand the production is still decreasing, due to the increased cost of fuel and[1] explosives.

Thorpe states that "In addition to the 16,000,000 tns of sulphur whch have been mined, prepared, and sold, it has been officially reported by a highly qualified engineer that the quantity of commercial sulphur, still in sight in the Sicilian deposits, amounts to about 34,000,000 tons."

Japan.—The exports of sulphur from Japan, prior to the war, were declining rapidly. They continued to decrease until the entrance of Italy in the war. The participation of Italy must have curtailed its output with a resulting shortage and keen demand in the European markets. Moreover, there has arisen a new demand for Japanese sulphur for war use in Russia. This has resulted in greatly increased exports from Japan to that country. The following table from the Mineral Industry, 1916, page 672, shows the exports from Japan for 1914 and 1915, classified according to the destination.

This table also illuustrates the increase in the production of sulphur in Japan.

[1] Thorpe: Dictionary of Applied Chemistry, vol. 5, p. 287.

Exports of sulphur from Japan.

Country.	Exports.	
	1914	1915
	Pounds.	*Pounds.*
Australia	52,204,636	63,356,168
Canada	3,975,658	11,586,428
India	2,111,053	10,524,868
Russia	734,815	11,819,997
United States	41,609,098	60,655,332
Total	100,635,260	157,942,793

The production of sulphur in Japan for the year 1916 was 92,677 metric tons, an increase of 50.9 per cent over that of 1915. It seems improbable that Japan will be able to maintain this increased production at the close of war, with normal conditions restored in ocean shipping.

The ruling price for sulphur in Japan during 1916 was $35 per ton f. o. b.[1] Yokohama.

Chile.—During the year 1915 there was unusual activity exhibited in the sulphur industry in Chile. The production was much in excess of any previous year. Plans for still increasing the output were formulated, and if carried out will require the companies to look about for new markets. At the present time the vineyards of southern Chile consume practically the entire output. Chile and also Peru contain a number of undeveloped sulphur deposits, which have as yet received no attention. The greatest obstacle to the development of these deposits is the fact that they occur at very high altitudes. The difficulties of transportation in Chile have restricted the development of the industry, but this in part has been remedied. The production of sulphur in 1914 in Chile was 10,008 metric tons.

Production of sulphur in principal countries.[2]

Country.	Quantity in long tons.					
	1900	1901	1902	1903	1904	1905
Austria [3] [4]	969	4,967	3,764	4,536	6,327	8,404
Chile	2,432	2,475	2,594	3,503	3,536	3,414
France [3]	11,365	6,726	7,892	7,256	5,359	4,562
Germany	1,422	947	479	215	206	202
Greece	877	2,298	1,369	1,246	1,205	1,108
Italy [3]	535,359	554,030	502,117	554,836	519,069	559,767
Japan	14,207	16,283	17,992	22,545	25,175	24,255
Spain	738	600	443	1,653	595	600
United States	4,555	6,864	7,443	35,086	193,423	214,923
Total	571,923	595,195	544,093	620,876	754,895	817,235

[1] Commerce Reports, Feb. 28, 1917.
[2] Converted from the table on world's production of sulphur in Mineral Industry.
[3] Crude mineral, limestone impregnated with sulphur.
[4] Includes such production from Hungary.

Production of sulphur in principal countries—Continued.

Country.	Quantity in long tons.					
	1906	1907	1908	1909	1910	1911
Austria	15,012	23,809	17,148	12,649	15,719	15,601
Chile	4,524	2,858	2,661	4,435	3.761	4,379
France	2,669	1,968	2,154	2,853	2,598	1,181
Germany	175	173	799	1,166	1,252	1,231
Greece	[1] 984	[1] 984	[1] 984	[1] 984	.....	171
Italy	491,767	420,098	438,142	428,056	423,431	407,995
Japan	27,145	32,792	32,881	35,732	43,142	51,226
Spain	689	3,554	13,649	21,400	29,628	40,007
United States	293,895	307,696	307,666	298,122	255,518	242,335
Total	832,336	789,000	816,084	804,445	775,049	764,126

Country.	Quantity in long tons.					
	1912	1913	1914	1915	1916	1917
Austria	14,738	10,391	.....	.....	.....	.....
Chile	4,360	6,540	9,847	.....	.....	.....
France	984	648	.....	.....	.....	.....
Germany	[2]	.....	.....	.....	.....	.....
Greece	1,984	[3]	[3]	.....	.....	.....
Italy	351,790	343,973	397,061	374,118	91,185	.....
Japan	54,119	58,523	58,886	60,416	.....	.....
Spain	41,662	61,644	[2]	28,471	.....	.....
United States	303,563	311,683	327,732	[1] 410,000	[1] 900,000	[1] 1,350,000
Total	773,200	.....	.....	.....	.....	.....

[1] Estimated. [2] Not yet reported. [3] Nil.

METHODS OF MINING.

Sulphur was first mined in Sicily. The deposits in this country occur at a depth of from 150 to 650 feet, the sulphur being associated with gypsum. The ore which contains at the most 40 per cent of sulphur was, formerly, brought to the surface on the backs of laborers. Later this method was replaced by the installation of mechanical hoisting apparatus. The sulphur is then removed from the gangue by melting; part of the sulphur itself is used as fuel. This method recovers only about 60 per cent of the sulphur in the ore. Steam extraction of sulphur has been successfully applied at Romanga, Italy, but this process does not appear to be practicable on a large scale in Sicily, due to the high cost of fuel and to the large losses occasioned by the large amounts of gypsum associated with the sulphur.

The deposits, from which sulphur is obtained in the United States, are geographically associated with the "Dome formations." The Louisiana deposit, which is a typical one, has an average depth of 125 feet; it is about one-half mile in diameter; and it contains not less than 40,000,000 tons of sulphur. This deposit has an overburden of about 450 feet, which is mainly quicksand impregnated with hydrogen sulphide waters. It was this overburden that caused the failure of the ordinary mining methods when applied to this deposit.

The difficulties were overcome by a radically new process, which was invented by Herman Frasch. In essentials the process consists in introducing superheated water into the sulphur beds, the sulphur is thereby melted and blown to the surface by means of hot compressed

air. This is accomplished by drilling, and sinking concentric pipes into the sulphur bed. The superheated water is introduced through one pipe, compressed air through a second, and the sulphur rises through the third one. One of these wells usually produces about 70,000 tons of sulphur during its period of usefulness. This method requires large quantites of hot water, approximately 7,000 gallons per ton of sulphur mined. Crude oil is used as fuel, and its local availability and cheapness have largely contributed to the successful operation of the Frasch process.

The molten sulphur as it comes from the wells is run into large bins. It cools rapidly, thus enabling the sides of the bins to be raised with the increase in depth of the solidified sulphur. These bins often reach a height of 65 feet. In this manner blocks have been formed containing as much as 150,000 tons of sulphur.

When it is desired to ship the sulphur, a temporary track is laid parallel to the long side of the bin. The boards are removed from the sides and the sulphur is blasted down. It is then loaded into gondola cars by means of a large locomotive crane equipped with a grab bucket. The cars of sulphur on reaching the shipping port are emptied into the steamer by means of automatic machinery, which permits the docking, loading, and sailing of a steamer in 12 hours. From a shipping standpoint the mines of the United States are advantageously located. They are situated close to the Gulf ports, and also have direct connections with southern railways.

IMPORTANT USES.

1. Combating fungous diseases of plants, especially grapes and hops. This is a large use in France.
2. Manufacture of lime-sulphur solution, which is used as a fungicide for spraying trees and plants and also as a sheep dip. These are large uses in the United States.
3. The production of sulphur dioxide, which in turn is used for the following purposes:

   Sulphite process of digesting wood pulp. About 150,000 tons were used in the United States in 1916. This is the largest single use in normal times.

   The manufacture of sulphuric acid, especially the grades of higher strength and purity.

   The bleaching of silk and straw.

   Disinfection purposes.

   Preservation of beverages and food, especially dried fruits.

   Manufacture of sodium sulphite and bisulphite.

4. Vulcanization of rubber.
5. The manufacture of matches.
6. Old-fashioned gunpowder. Sulphur, however, is not used as an ingredient of the modern smokeless powder.
7. Manufacture of certain varieties of cements.
8. Manufacture of carbon disulphide.
9. Manufacture of sulphur chlorides.
10. In the dye industry.
11. Manufacture of sodium thiosulphate, commonly known as "hypo" in the photographic trade.
12. Vulcanization of corn and linseed oils.

COST OF PRODUCTION.

The report of the Federal Trade Commission to the President on profiteering, in response to Senate resolution 255, which was published in the Official Bulletin, No. 348, June 29, 1918, contains the following statements on the cost of producing sulphur in the United States:

"Two companies produce all the sulphur in this country—the Freeport Sulphur Co. and the Union Sulphur Co."

"The cost of the Freeport Co. in 1917 was $6.15 per ton; in 1918 it is estimated that increases will bring the cost up to not over $9.50 per ton. In the first half of 1917 the Union Co.'s costs were $5.73 per ton. The average realization of the Union Co. in the first half of 1917 was $18.11 per ton, making a margin of $12.38 per ton. The manufacturers of sulphuric acid are paying in the neighborhood of $25 per ton, and some as high as $35 per ton, making margins of over $15 per ton for sulphur companies. The Freeport Co.'s balance sheets show an operating profit for the 11 months ending October 31, 1917, of $4,301,310, or 236 per cent on investment. On November 30, 1916, the company's balance sheets show dividends declared of $925,000; on July 31, 1917, $1,850,000; and October 31, 1917, $2,600,000. Its surplus increased from $1,254,000 in November, 1916, to $2,543,000 in October, 1917."

"These companies may be said to have a natural monopoly of sulphur. Since they have placed their operations upon an established basis, they have always made large earnings. They have taken advantage of the existing situation to raise their price."

IMPORTS OF SULPHUR.

Imports by countries.

[Fiscal years.]

Imported from—	1902		1909		1910		1911	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
Italy	163,571	$3,111,971	8,371	$148,632	11,399	$214,485	8,753	$167,460
United Kingdom	7,681	161,387	2	58	7	199	10	242
North America	.....	.....	5	75	297	7,235	5	160
Japan	15,448	290,826	9,433	156,880	17,195	275,797	14,705	243,998
South America	.....	.....	76	1,223	200	2,516	.....	.....
China	.....	.....	.....	.....	230	3,414	.....	.....
All other	780	18,700	20	339	1	24	4	112
Total	187,480	3,582,884	17,907	307,207	29,329	503,670	25,496	411,972

Imported from—	1912		1913		1914	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
Italy	6,175	$120,860	6	$153	732	$19,675
United Kingdom	10	238	.....	.....	224	6,217
North America	32	829	98	2,372	12	500
Japan	19,279	331,789	18,653	363,081	18,406	328,519
All other	.....	.....	.....	.....	15	539
Total	25,496	453,716	18,757	365,606	19,389	355,450

Imports by countries—Continued.

Imported from—	1915		1916		1917		1918	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
Italy	157	$3,608	201	$5,831	.....	.....	.....	.....
United Kingdom	1	23	.....	.....	5	$211	.....	.....
North America	90	2,000	30	540	13	483	4	$75
Japan	26,117	439,587	22,539	372,599	11,791	205,286	278	8,602
Total	26,365	445,218	22,770	378,970	11,809	205,980	282	$8,677

Imports for consumption—Revenue.

SULPHUR OR BRIMSTONE, CRUDE.

Fiscal year.	Rates of duty.	Quantities (long tons).	Values.	Duties collected.	Value per unit of quantity (long tons).	Actual and computed ad valorem rate (per cent).
1909	Free	17,897	$307,207	.....	$17.17	.....
1910	.....do	31,233	537,778	.....	17.22	.....
1911	.....do	23,380	409,990	.....	17.54	.....
1912	.....do	25,545	453,754	.....	17.76	.....
1913	.....do	19,257	374,024	.....	19.42	.....
1914 [1]	.....do	6,848	124,468	.....	18.18	.....
1914 [2]	.....do	13,388	222,407	.....	16.61	.....
1915	.....do	25,842	442,975	.....	17.14	.....
1916	.....do	22,539	372,599	.....	16.53	.....
1917	.....do	11,819	205,980	.....	17.42	.....
1918	.....do	282	8,677	.....	30.77	.....

SULPHUR, SUBLIMED, OR FLOWERS OF.

1909	$8 per ton	426	$13,035	$3,404	$30.60	26.12
1910 [3]	.....do	345	9,956	2,759	28.87	27.71
1910 [4]	$4 per ton	821	23,914	3,283	29.14	13.73
1911	.....do	969	27,296	3,877	28.16	14.20
1912	.....do	3,921	87,062	15,686	22.20	18.02
1913	.....do	6,104	122,093	24,416	20.00	20.00
1914 [1]	.....do	289	7,801	1,158	26.95	14.84
1914 [2]	Free	309	8,040	.....	26.01	.....
1915	.....do	950	31,202	.....	32.84	.....
1916	.....do	200	7,512	.....	37.56	.....
1917	.....do	295	13,317	.....	45.14	.....
1918 [5]	.....	.....	.....	.....	.....	.....

REFINED SULPHUR.

1909	$8 per ton	751	$19,966	$6,005	$26.59	30.08
1910 [3]	.....do	50	1,335	398	27.26	29.34
1910 [4]	$4 per ton	916	22,723	3,666	24.79	16.13
1911	.....do	999	24,072	3,997	24.09	16.60
1912	.....do	1,393	35,448	5,570	25.45	15.72
1913	.....do	1,742	41,626	6,969	23.89	16.74
1914 [1]	.....do	147	3,815	587	26.00	15.83
1914 [2]	Free	1,376	35,819	.....	26.03	.....
1915	.....do	1,296	36,275	.....	28.00	.....
1916	.....do	850	26,778	.....	31.50	.....
1917 [5]	.....	.....	.....	.....	.....	.....
1918 [5]	.....	.....	.....	.....	.....	.....

[1] July 1 to Oct. 3, 1913.
[2] Oct. 4, 1913, to June 30, 1914.
[3] July 1 to Aug. 5, 1909.
[4] Aug. 6, 1909, to June 30, 1910.
[5] Not listed.

Imports for consumption—Revenue—Continued.

SULPHUR, LAC OR PRECIPITATED.

Fiscal year.	Rates of duty.	Quantities (long tons).	Values.	Duties collected.	Value per unit of quantity (long tons).	Actual and computed ad valorem rate (per cent).
1909	Free	114,699	$7,442	.....	$0.065	.....
1910	.....do	110,886	6,672	.....	.060	.....
1911	.....do	130,633	8,098	.....	.062	.....
1912	.....do	150,952	9,670	.....	.064	.....
1913	.....do	715,876	13,723	.....	.019	.....
1914	.....do	233,896	13,636	.....	.058	.....
1915	.....do	208,568	13,187	.....	.063	.....
1916	.....do	217,997	16,628	.....	.076	.....
1917	.....do	69,145	7,009	.....	.101	.....
1918	.....do	84,224	10,797	.....	.128	.....

DOMESTIC EXPORTS OF SULPHUR.

Exports of sulphur have increased from 45,595 long tons, valued at $864,808, in 1910 to 177,548 long tons, valued at $3,595,512, in 1917. In 1918 the export of sulphur decreased to 140,525 long tons, valued at $3,842,512. The exports of sulphur have been chiefly to Canada. The following table shows the exports of sulphur by countries since 1909.

DOMESTIC EXPORTS (SULPHUR OR BRIMSTONE).

Exported to—	1909		1910		1911	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
France	12,450	$249,000	25,570	$471,475	.....	.....
Germany	4,570	91,400	1,999	38,032	1,355	$26,560
Netherlands	1,650	33,000	1,113	22,854	.....	.....
Canada	8,125	162,734	15,226	297,557	14,104	267,099
Mexico and Central America	120	2,486	10	197	18	377
Newfoundland and Labrador	.....	.....	1,500	31,000	1,500	26,250
West Indies	9	188	168	3,455	263	5,729
All other	4,601	91,719	9	238	29	720
Total	31,525	630,527	45,595	864,808	17,269	326,735

Exported to—	1912		1913		1914	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
France	18,100	$339,550	38,260	$682,550	48,500	$851,650
Germany	3,790	78,300	8,241	147,407	20,220	406,350
Netherlands	800	16,000	.....	.....	13,100	229,250
Canada	16,697	313,439	23,720	448,719	18,964	364,909
Mexico and Central America	171	3,470	663	15,988	781	16,780
Newfoundland and Labrador	1,400	27,300	2,500	48,750	4,000	70,000
West Indies	309	6,248	413	8,458	297	6,167
All other	2	42	64	1,438	[1] 4,160	73,618
Total	41,269	784,349	73,861	1,353,310	110,022	2,018,724

[1] Includes 4,000 tons to French Africa.

DOMESTIC EXPORTS (SULPHUR OR BRIMSTONE)—Continued.

Exported to—	1915		1916		1917	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
France	6,804	$119,072	8,000	$160,000	22,977	$470,067
Germany						
Netherlands	6,450	112,875	2	85		
Canada	33,165	602,692	44,552	814,620	69,895	1,316,844
Mexico and Central America	674	19,816	1,426	33,709	6,823	127,775
Newfoundland and Labrador					4,002	70,104
West Indies	255	7,630	419	10,400	2,935	64,137
South America	455	11,231	571	14,742	3,100	122,229
Norway and Sweden	480	9,700	12,793	263,852	27,682	563,888
All other	108	2,740	697	16,882	40,134	860,468
Total	48,391	885,756	68,460	1,314,290	177,548	3,595,904

Exported to—	1918	
	Long tons.	Value.
France	4,938	$103,424
Canada	90,859	2,169,701
Mexico and Central America	7,924	233,933
All other	36,804	1,335,846
Total	140,525	3,842,904

WHOLESALE PRICES OF SULPHUR.

From 1909 to February, 1916 the price of sulphur remained absolutely constant at $22 per ton f. o. b. New York. In March, 1916, the price was raised to $28.50 per ton on the plea that scarcity of ocean shipping made it necessary to ship by rail. By June, 1916 the price of spot sulphur had increased to $35 per ton, although trade papers reported that future contracts could be secured at $30 per ton. In March, 1917, there was a further advance in price to $45 per ton, which was the high level during the war. The following table shows the price of sulphur by quarters since 1912.

Sulphur or brimstone (wholesale), per long ton, spot, New York.

[Data from Oil, Paint, and Drug Reporter.]

Years.	January.	April.	July.	October.
1912	$22 @ $22.50	$22 @ $22.50	$22 @ $22.50	$22 @ $22.50
1913	22 @ 22.50	22 @ 22.50	22 @ 22.50	22 @ 22.50
1914	22 @ 22.50	22 @ 22.50	22 @ 22.50	22 @ 22.50
1915	22 @ 22.50	22 @ 22.50	22 @ 22.50	22 @ 22.50
1916	22 @ 22.50	29 @ 30.00	— @ 35.00	— @ 35.00
1917	— @ 35.00	45 @ —	45 @ —	45 @ —
1918	35 @ 45.00	Nominal.	Nominal.	30 @ —
1919	28 @ 35.00	28 @ 35.00		

Sulphur, roll, wholesale, in dollars per 100 pounds, spot, New York.

[Data from Oil, Paint, and Drug Reporter.]

Years.	January.	April.	July.	October.
1912	1.85 @ 2.15	1.85 @ 2.15	1.85 @ 2.15	1.85 @ 2.15
1913	1.85 @ 2.15	1.85 @ 2.15	1.85 @ 2.15	1.85 @ 2.15
1914	1.85 @ 2.15	1.85 @ 2.15	1.85 @ 2.15	1.85 @ 2.15
1915	1.85 @ 2.15	1.85 @ 2.15	1.85 @ 2.15	1.85 @ 2.15
1916	1.85 @ 2.15	1.95 @ 2.25	1.95 @ 2.25	1.95 @ 2.25
1917	1.95 @ 2.25	2.20 @ 2.50	3.70 @ 4.15	3.70 @ 4.15
1918	3.70 @ 4.15	.....	.....	3.70 @ —
1919	3.20 @ —	2.70 @ —	.....	.....

Sulphur, flour, wholesale, in dollars per 100 pounds, spot, Nem York.

[Data from Oil, Paint, and Drug Reporter.]

Years.	January.	April.	July.	October.
1912	$2.00 @$2.40	$2.00 @$2.40	$2.00 @$2.40	$2.00 @$2.40
1913	2.00 @ 2.40	2.00 @ 2.40	2.00 @ 2.40	2.00 @ 2.40
1914	2.00 @ 2.40	2.00 @ 2.40	2.00 @ 2.40	2.00 @ 2.40
1915	2.00 @ 2.40	2.00 @ 2.40	2.00 @ 2.40	2.00 @ 2.40
1916	2.00 @ 2.40	2.10 @ 2.50	2.10 @ 2.50	2.10 @ 2.50
1917	2.10 @ 2.50	2.35 @ 2.75	3.85 @ 4.40	3.85 @ 4.40
1918	3.85 @ 4.40	3.25 @ —	3.50 @ —	3.85 @ —
1919	3.35 @ —	2.85 @ —	.....	.....

Sulphur, flowers of, wholesale, in dollars per 100 pounds, spot, New York.

[Data from Oil, Paint, and Drug Reporter.]

Years.	January.	April.	July.	October.
1912	$2.20 @$2.60	$2.20 @$2.60	$2.20 @$2.60	$2.20 @$2.60
1913	2.20 @ 2.60	2.20 @ 2.60	2.20 @ 2.60	2.20 @ 2.60
1914	2.20 @ 2.60	2.20 @ 2.60	2.20 @ 2.60	2.20 @ 2.60
1915	2.20 @ 2.60	2.20 @ 2.60	2.20 @ 2.60	2.20 @ 2.60
1916	2.20 @ 2.60	2.30 @ 2.70	2.30 @ 2.70	2.30 @ 2.70
1917	2.30 @ 2.70	2.55 @ 2.95	4.05 @ 4.60	4.05 @ 4.60
1918	4.05 @ 4.60	4.05 @ —	4.05 @ —	3.95 @ —
1919	3.55 @ —	3.05 @ —	.....	.....

TARIFF HISTORY.

Crude sulphur or brimstone has been free of duty since the passage of the act of 1883. Sulphur, refined, sublimed, or flowers of sulphur was dutiable until the passage of the act of 1913 when sulphur in every form was placed on the free list. The table following shows the rates of duty on sulphur under the various tariff acts.

Rates of duty.

Act of—	Paragraph.	Tariff classification or description.	Rates of duty specific and ad valorem.
1883.....	77	Sulphur, refined in rolls.....	$10 per ton.
	78	Sulphur, sublimed, or flowers of.....	$20 per ton.
	632	Sulphur, or brimstone, n. s. e. or p. f. in this act.....	Free.
	633	Sulphur, lac or precipitated.....	Do.
1890.....	88	Sulphur, refined.....	$8 per ton.
		Sulphur, sublimed or flowers of.....	$10 per ton.
	727	Sulphur, lac or precipitated, and sulphur or brimstone crude, in bulk, ..., and sulphur n. o. p. f.	Free.
1894.....	71	Sulphur, refined, sublimed, or flowers of.....	20 per cent.
	642	Sulphur, lac or precipitated, and sulphur or brimstone, crude, in bulk, ..., and sulphur n. o. p. f.	Free.
1897.....	84	Sulphur, refined or sublimed, or flowers of.....	$8 per ton.
	674	Sulphur, lac or precipitated, and sulphur or brimstone, crude, in bulk, ..., and sulphur n. o. p. f.	Free.
1909.....	81	Sulphur, refined or sublimed, or flowers of.....	$4 per ton.
	686	Sulphur, lac or precipitated, and sulphur or brimstone, crude, in bulk, ..., and sulphur n. o. p. f.	Free.
1913.....	617	Sulphur in any form, brimstone.....	Do.

COURT AND TREASURY DECISIONS.

Litigation turned upon what constitutes refined sulphur. Ground sulphur invoiced as "soufre raffine en masse," and described as "the residue of the process of sublimation for the production of the article known as 'flower of sulphur,'" was held neither "sulphur refined in rolls" nor "sublimed, or flowers of sulphur" but sulphur not specially provided for, within the act of 1883. (Appeal, T. D. 8442, of 1887.)

So-called recovered sulphur, extracted from the alkali waste obtained in manufacturing soda from salt, though used like refined sulphur in some of the arts, was classified as "sulphur not otherwise provided for," and not as refined under the act of 1890. (G. A. 432, T. D. 10937 of 1891.)

Sulphur ground but subjected to no process of sublimation or distillation was held crude, or sulphur not otherwise provided for, and not refined, under the act of 1894. (G. A. 3742, T. D. 17756 of 1896.) This decision overruled G. A. 1409, T. D. 12813, of 1892, holding sulphur with a residue of 0.3 per cent after calcination dutiable as refined.

But ground or roll sulphur, with less than one-half of 1 per cent of impurities, was held within the provision in paragraph 84 of the act of 1897 for "sulphur, refined or sublimed, or flowers of," carrying a duty of $8 per ton. (Vandivers *v.* United States, 156 Fed. 961, T. D. 28521, of 1907; Jordan *v.* United States, T. D. 28210, Suit 4353 of 1907; contra (prior case not fully prosecuted), United States *v.* Corbitt, T. D. 27653, of 1901, declaring refined sulphur of commerce to be not rolled but powdered.)

Sulphur mined in Hokkaido, Japan, and containing from 90 to 97 per cent of pure sulphur, was held not refined. (T. D. 31962, of 1911, reversing T. D. 31775.) So also was Japanese sulphur called "Bungo," which is expelled by volcanic force from geysers, in almost a pure state, then drawn off in conduits and when cooled, broken into lumps and packed in sacks for transportation. Refined or sublimed sulphur was declared to be the result of one or more processes of artificial sublimation and not a pure or substantially pure naturally

produced sulphur. Sublimation was defined as the artificial distillation of sulphur in the course of which the sulphur content is, after evaporation, deposited, collected and formed according to the commercial or other designed uses. "Crude" was interpreted as referring to substances or articles in a condition unfit for the intended ultimate purpose or use. (Newhall *v.* United States, 4 Ct. Cust. Appls., 134, of 1913.)

A certificate attached to the invoice and reciting that the sulphur had not been sublimed was accepted as sufficient proof for the free entry of Japanese sulphur. (Dept. Order, T. D. 33556, of 1913.)

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Journal of Industrial and Engineering Chemistry. Volume 4, 1912.

PRODUCERS OF CRUDE SULPHUR, BRIMSTONE.

The Union Sulphur Co., 17 Battery Place, New York. Sulphur, La.
The Freeport Sulphur Co., Freeport, Tex.
The Texas Gulf Sulphur Co., 50 East Forty-Second Street, New York.
American Sulphur Co., Thermopolis, Wyo.
Cuprite Sulphur Mining Co., Los Angeles, Calif.
The Nevada Sulphur Co.
Midwest Sulphur Co., Park County, Wyo.
Sulphur Mining & Railroad Co., Richmond, Va.

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